STRATIFICATION IN DOUBLE SAMPLING -- "THE EASY WAY
OUT MAY SOMETIMES BE THE BEST WAY"

by

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Double sampling with aerial photo and ground plots is commonly used for timber
inventories. Most of these inventories have several parameters of interest.
Take, for example, the estimation of forest area in a large land area such as
a state. A typical inventory of a state might include several thousand aerial
photo plots with a subsample of several hundred ground plots.

Assume that we have 80,000 photo plots with 500 to be selected for ground
examination. We might do the following:

    (1) Stratify the 80,000 photo plots into two categories -- forest
          and nonforest

    (2) Select some plots at random from each category for ground examination.

The ground classification may differ from the photo classification because of
changes which have occurred since the date the photos were taken. Also, there
is a possibility of error because of misclassification by the photo interpreters.

We might arrive at these results:

    64,526 photo plots classified as forest
    15,474 photo plots classified as nonforest

If proportional allocation of ground plots is used, we may have:

    403 ground plots selected at random from the 64,526 plots classified as
    forest; ground examination reveals that 386 are acually forest and 17 are
    nonforest.

    97 ground plots selected at random from the 15,474 plots classified as
    nonforest; ground examination reveals that 87 are actually nonforest and
    10 are forest.

Our estimate of forest area at the time of ground examination (assuming that
the state has 20,580,000 acres of land area) is

$$FA = A \Sigma \frac{N_i}{N} P_1$$

    where   A = land area
              N_i = primary sample size (photo plots) in stratum i

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$$N = \Sigma N_i$$

P_i = estimated proportion of forest area in stratum i

$$FA = 20,580,000 \left\{ \left(\frac{64,526}{80,000} \right) \left(\frac{386}{403} \right) + \left(\frac{15,474}{80,000} \right) \left(\frac{10}{97} \right) \right\} = 16,309,000 \text{ acres}$$

with variance

$$S^2_{FA} = \frac{A^2}{N(N-1)} \left[\Sigma \left\{ N_i(N_i-1) \left(\frac{P_i - P_i^2}{n_i - 1} \right) \right\} + \Sigma \left\{ N_i(P_i - P)^2 \right\} \right]$$

where $P = \Sigma \frac{N_i}{N} P_i$

n_i = secondary sample size (ground plots) in stratum i

$$S_{FA} = 209,000$$

This is a common procedure and the results are typical of many such statewide inventories. Many photo plots were used, but they are relatively cheap in relation to ground plots. Sometimes, however, there is a way to make the photo interpretation task even easier (and cheaper) and at the same time improve the precision of estimated forest area.

Most of the photo plots were probably easy to classify. The ones which took the most time on the part of the photo interpreters (and consequently were the most expensive to handle) were the ones which were doubtful. You've seen it before: An interpreter looks at a photo plot, is unsure how to classify it and after looking at it some more he asks advice of other interpreters. Finally, after spending much more time on this than the "easy" ones, it's put into one class or the other.

Let's try an alternative. Let's create a third class which represents all the photo plots which are difficult to classify. Don't spend time on any plot which is doubtful; just put it in this class.

Applying this to the same problem given above, we may have the following results:

64,101 photo plots classified as forest

15,104 photo plots classified as nonforest

795 photo plots not classified as either

Again, using proportional allocation, we have:

> 401 ground plots selected at random from the 64,101 plots classified as forest; ground examination reveals that 396 are actually forest and 5 are nonforest.

> 94 ground plots selected at random from the 15,104 plots classified as nonforest; ground examination reveals that 93 are actually nonforest and 1 is forest.

> 5 ground plots selected at random from the 795 photo plots classified as doubtful; ground examination reveals that 2 are actually forest and 3 are nonforest.

$$FA = 20,580,000 \left\{ \left(\frac{64,101}{80,000}\right)\left(\frac{396}{401}\right) + \left(\frac{15,104}{80,000}\right)\left(\frac{1}{94}\right) + \left(\frac{795}{80,000}\right)\left(\frac{2}{5}\right) \right\}$$

$$= 16,408,000 \text{ acres}$$

$$S_{FA} = 116,000$$

Thus, by taking the "easy way out," we have realized a reduction in the standard error of the estimate from 209,000 to 116,000. We were able to do this by absorbing most of the photo interpretation error into one class which represents a small segment of the population. At the same time we have reduced photo interpretation costs.

FORESTRY

0008-2 "Forest Inventory - Iran - The Caspian Forest Inventory" and 0008-3
"The Zagros Forest Inventory" by James C. Space. Requests for copies
should be directed to: Forest Service, USDA, James C. Space, Computer
Systems Applications Staff, P.O. Box 2417, Washington, D.C. 20013.

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"Metric Site Index Formulae for Major Canadian Timber Species" in Bimonthly
Research Notes, Vol. 33, No. 5, Sept. - Oct. 1977. Available from Dept. of
Fisheries and the Environment, Ottawa, Ontario K1A OE7 Canada.

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"Algunas Consideraciones y Conceptos Sobre Muestreo en Areas Forestales" in
Bosques y Fauna, Vol. XIV, No. 1 p. 3-7. Available from Bosque y Fauna,
Av. Mexico 190, Coyoacan 21, D.F. Mexico.

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"Economic Analysis - Phase II - Washington Forest Productivity Study" from
State of Washington, Dept. of Natural Resources, Olympia, WA 98504.

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G77-334 "Timber Sale Contracts" is available from Cooperative Extension
Service, University of Nebraska, Lincoln, NE 68583.

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Forest Inventory - Volume I, second edition "Statistics of Forest Inventory
and Information from Aerial Photographs" and Volume II "Collection of Data
in the Field and Related Sources of Bias, Fundamentals of EDP and Methodical
Components for Inventory Planning" by Loetsch, Zohrer and Haller available
from BLV Verlagsgesellschaft MBH, D-8 Munchen 40, Lothstrasse 29, P.O. Box
40 03 20, Fed. Rep. of Germany. The prices are DM 150 and DM 195 respectively.

RANGE and WILDLIFE

Extension Folder 346-1977 "Judging Dairy Cattle" from Agricultural Extension
Service, Inst. of Agriculture, University of Minnesota, St. Paul. MN 55108.

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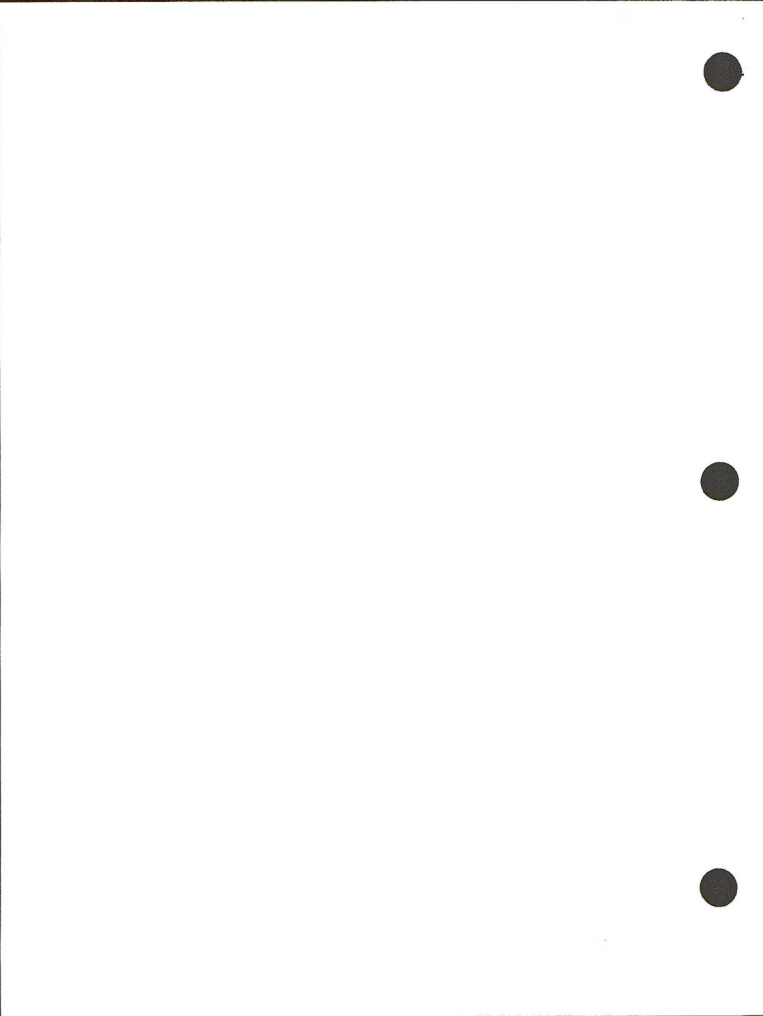
G75-205 "Estimating Hay in Stacks"
   and
EC 76-131 "Nebraska Handbook of Range Management" from USDA Extension Service,
University of Nebraska, Institute of Agriculture and Natural Resources,
Lincoln, NE 68583.

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Information Leaflet No. 172 "The Use of the Coded Wire Tag Injector Under
Remote Field Conditions" from State of Alaska, Dept. of Fish & Game,
Subport Bldg. Juneau, AK 99801.

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RECREATION

WRRI Bulletin 27 "An Unobstrusive Measure of the Recreational Value of a Lake"
may be purchased from Water Resources Research Institute, 205 Samford Hall,
Auburn University, Auburn, AL 36830. The price is $2.00.

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"Guidelines for Understanding and Determining Optimum Recreation Carrying
Capacity". from U.S. Dept. of Interior, Bureau of Outdoor Recreation,
Washington, D.C. 20240.

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Forestry Res. Notes 264. "A Technique to Determine Objective and Emotional
Reactions to Establishing Voyageurs National Park" from College of Forestry,
110 Green Hall, 1530 N. Cleveland Ave., University of Minnesota, St. Paul,
MN 55108.

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WATERSHED and SOILS

Completion Report "The Detection and Mapping of Subterranean Water Bearing
Channels" from Missouri Water Resources Research Center, 424 Clark, University
of Missouri, Columbia, MO 65201.

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Brochures "River-Quality Assessment", and NASQAN – Measuring the Quality of
America's Streams" and USGS Circular 719 "The National Stream Quality
Accounting Network (NASQAN) – Some Questions and Answers" are available from
Branch of Distribution, U.S. Geological Survey, 1200 South Eads St.,
Arlington, VA 22202.

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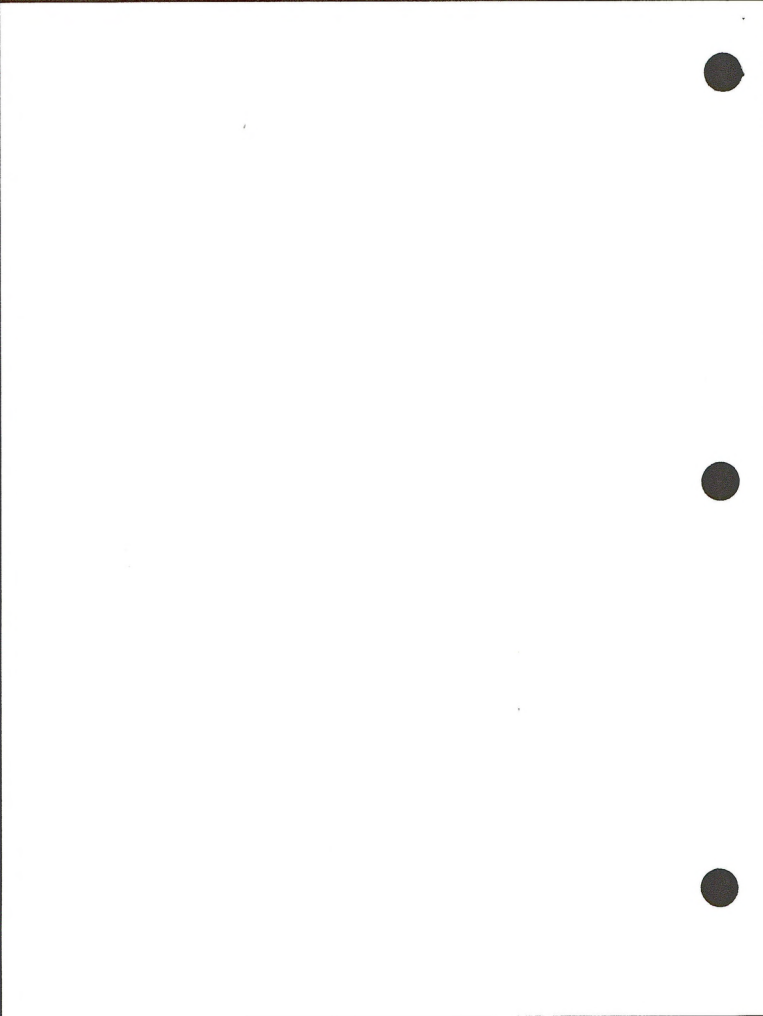
Bulletin 212 "Criteria for Making and Interpreting a Soil Profile Description" from: Kansas Geological Survey, 1930 Avenue "A", Campus West, University of Kansas, Lawrence, KS 61044. Price $3.50.

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Cir. 476 "Soil Classification in Hawaii" from: Cooperative Extension Service, University of Hawaii, Honolulu, HI 97822.

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Remote Sensing

Proceedings "Aerial Color Photography in the Plant Sciences and Related Fields" sponsored by the Society of American Foresters, American Society of Photogrammetry and Colorado State University. Contact Bob Heller, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, ID 83843 for availability.

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The Vol. No. 10 - November 1977 issue of _Pixel Facts_ contains an excellent "Project Documentation Outline for use in Remote Sensing Studies." Copies of _Pixel Facts_ are available from: NASA, Ames Research Center, Moffett Field, CA 94035.

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"Specifications et Recommandations Concernant Quelques Instruments Metriques de Mesure Dans Le Secteur Forestier Canadien".

Reprint - "Colour Graphic Display Aid's Resource Mapping for Forest Management Research" by Peet.

"Resources for Teaching Remote Sensing" by L. Sayn-Wittgenstein. - are all available from Forest Management Institute, Canadian Forestry Service, Ottawa, Ontario, K1A 0W2 Canada.

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General

Res. Note NE-236 "RIDGE - A Computer Program for Calculating Ridge Regression Estimates"
    and
Gen. Tech. Rept. NE-32 "A Computer Program for Analyzing PERT Networks" - are both available from the Northeastern Forest Exp. Sta., 6816 Market St., Upper Darby, PA 19082.

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Reprint "Resource Allocation Through Goal Programming" by Bottoms and Bartlett. Available from: Department of Range Science, Colorado State University, Ft. Coloins, CO 80523.

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Coop. Ext. Pub. 1917 "Use Value Assessment .... Everything You Wanted to Know About It, but Were Afraid to Ask Your Assessor" from: Louisiana Cooperative Extension Service, Knapp Hall, Baton Rouge, LA 70803.

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Cir. 232 "Simplified Programming as a Farm Management Tool" from: Agricultural Exp. Station, Auburn University, Auburn, AL 36830.

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R&S Report Issue No. 13. "Population Survey, 1976 Methodology and Procedures" from Research and Statistics Office, State Dept. of Health, P.O. Box 3378, Honolulu, HI 97801.

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"Richtwerte fur Die Freiraumplanung" may be obtained from Dr. N.C. M. Prodan, 78 Freiburg, Wallstr. 22, West Germany.

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Meetings

"Aerial Photography/Aerial Photo Interpretation Workshop sponsored by the College of Forestry, Wildlife and Range Sciences and Office of Continuing Education, University of Idaho, February 27 - March 3, 1978.

The course is for those land resource managers who have not had or who need a refresher on such topics as: obtaining aerial photography, small format camera systems, preparing and viewing aerial photos stereoscopically, determining scale, distances, heights, slopes, and area, making simple maps, and interpreting vegetation and landform. Cost $100.

Contact Dr. Joseph J. Ulliman, College of Forestry, Wildlife and Range Sciences, University of Idaho, Moscow, Idaho 83843.

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The Laboratory for Applications of Remote Sensing (LARS) is sponsoring a series of short courses on Remote Sensing Technology and Applications. The four day courses are held monthly March through June.

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